SOUTH AFRICAN ASSOCIATION FOR
MARINE BIOLOGICAL RESEARCH

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Investigational Report No. 6

Shark attack and its relationship to temperature, beach patronage and the seasonal abundance of dangerous sharks

BY

DAVID H. DAVIES

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Published by
THE OCEANOGRAPHIC RESEARCH INSTITUTE
2 WEST STREET, DURBAN

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SHARK ATTACK AND ITS RELATIONSHIP TO SEA TEMPERATURE, BEACH PATRONAGE AND THE SEASONAL ABUNDANCE OF DANGEROUS SHARKS

by

David H. Davies

I. INTRODUCTION

Shark attack on humans off the east coast of the Republic of South Africa is considered to be a serious problem. Since 1940 there have been 58 attacks of which 24 were fatal (March, 1963) and although these figures are insignificant when compared to deaths due to other causes such as road accidents, the wide publicity given to shark attack has a far-reaching effect on the coastal communities whose livelihood is dependent on tourism.

Fifty-four of the fifty-eight attacks recorded have taken place in the province of Natal (see Fig. 1) and 26 of these took place along the South Coast of Natal (see Fig. 2), a coastal resort area approximately 100 miles in length. This area is almost entirely dependent on tourism and the sensationalism associated with the outbreak of shark attack during the years 1957-58 resulted in a serious economic recession in the area.

Enquiry has shown that a considerable amount of data are available relating to certain factors thought to be associated with shark attack on humans. Among these data are daily sea temperature records taken at Durban by the Beach Manager's office from as far back as 1929. In addition, records of local weather conditions on the Durban beaches such as wind direction, rain and cloud, together with beach patronage figures have been kept on a daily basis over long periods. Since 1952 when the shark nets were installed opposite the Durban beaches, the City Engineer of Durban has kept detailed records of catches of sharks, sea temperatures and turbidity. The factors that are given consideration in this paper are sea temperature, beach patronage and the seasonal variation in abundance of dangerous species of shark.

Documentation of shark attacks in Natal from 1940-58 is relatively good and since 1959 shark attacks have been thoroughly investigated and fully documented by the Oceanographic Research Institute in Durban. It is of interest, therefore, to examine these data in order to find out to what extent relationships can be established between them and the incidence of shark attack on humans.

In a review of the circumstances associated with shark attack by Schultz, Gilbert and Springer (1961), based on an examination of the data contained in the World Shark Attack File kept by Schultz (1958), it is stated that shark attacks occur with greater frequency at tempera-

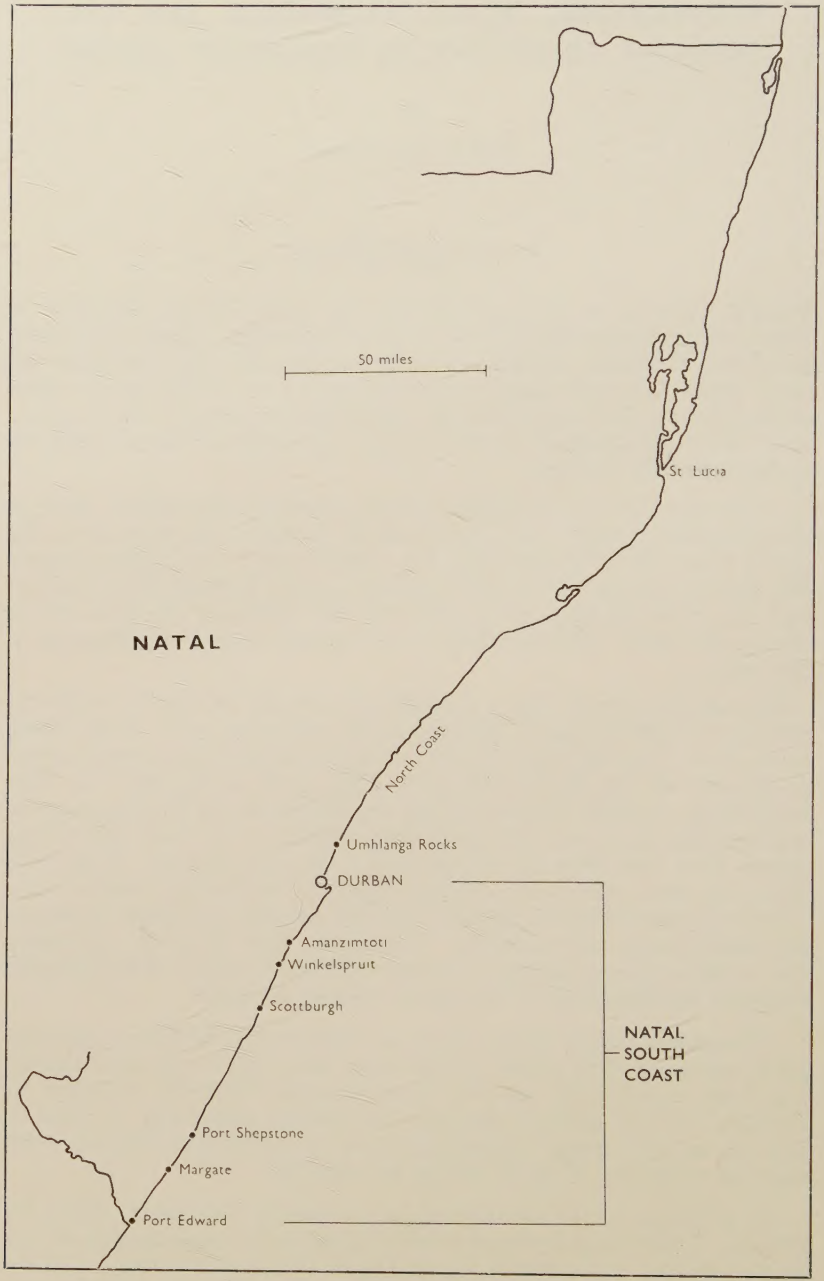

FIG. 2. The Natal South Coast

tures of 65°F* and warmer and that at least two factors contribute to this increased incidence. Firstly, the more dangerous species of shark such as the Blue Pointer (*Carcharodon carcharias*), the Tiger (*Galeocerdo cuvieri*) and certain of the Grey Sharks (*Carcharinidae*) are most abundant in warm waters and enter temperate zones during the periods when a seasonal increase in temperature takes place. Secondly, relatively few swimmers enter water colder than 65°F so that the seasonal warming up of temperate waters is accompanied by an increase in the numbers of bathers, together with an increase in the numbers of dangerous sharks.

Fig. 1 THE REPUBLIC OF SOUTH AFRICA

Examination of the data available for Natal gives some indication of the validity of these theories and others related to the circumstances surrounding shark attack on humans.

The factors affecting shark attack on humans are apparently numerous and extremely complex, and the processes of enumeration of these

* The Fahrenheit scale has been used since the original data were recorded in °F. A Conversion Table to Centigrade is provided on page 32.

factors and their subsequent analysis with a view to the determination of their relative significance are likely to take some considerable time.

In this paper a preliminary consideration has been given of three factors which are thought to be among the most important. Detailed investigations into a number of other factors are in progress. Among these are the relationship between the incidence of shark attack and factors such as salinity, wind direction, turbidity, the geomorphology of the beaches, the effects of offshore whaling and the effect of the discharge of sewage and industrial wastes into the sea.

While the investigation of these various factors is taking place, basic research on the behaviour, biology and life history of the sharks of the Natal area are in progress and, as a result, knowledge of the sharks concerned is steadily increasing. This increased knowledge of the sharks and the circumstances surrounding attacks on humans should result in a better understanding of the problem and increase the chances of its solution.

II. THE RELATIONSHIP BETWEEN SHARK ATTACK AND SEA TEMPERATURE

In his world study of shark attack, Coppleson (1962) states that there is a close relationship between sea temperatures and shark attack and that 70°F is the critical temperature in this connection. An attempt has been made to find out whether sea temperature has any determinable bearing on shark attack in Natal using the extensive records of temperature which are in existence for this area.

The temperature data which have been considered consist of sea temperatures taken where shark attacks have occurred immediately following the attack. These temperatures have been taken since 1959 by arrangement with this Institute by lifesavers and by staff members of the Institute. In addition to these, the record of daily sea temperatures taken opposite the Durban Beach Office since 1929 have been of considerable value in assessing the relationship of temperature to the incidence of shark attack.

Temperature Records of Attacks

When the shark research programme of the Oceanographic Research Institute was started in 1959, steps were taken to ensure that accurate temperature measurements were made immediately after each attack as near as possible to the position in which the attack took place. This has resulted in the collection of 8 records for Natal and 3 outside the province viz. two at Xai Xai in Moçambique and one at East

London in the Cape Province. Table A below shows the temperatures recorded:

TABLE A

Temperature Records of Recent Shark Attacks

Name	Date	Locality	Temperature °F
D.D.	21. 4.61	Xai Xai*	82
C.H...	7. 2.62	Winklespruit	81
M.M.	22. 1.61	Amanzimtoti	79
R.N...	5. 2.62	Winklespruit	79
J.B.	7. 4.62	Umhlali	76
P.S.	24.12.60	Margate	75
M.L.	6. 1.61	Winklespruit	75
M.Z.	1. 2.61	East London*	75
G.W.	28.12.61	Umhlanga	75
B.M.	9. 4.62	Xai Xai*	73
M.H.	30. 4.60	Amanzimtoti	71

* Outside Natal

These temperatures are in conformity with Coppleson's 70°F critical level, Coppleson (1962), and show that attacks have taken place at relatively high temperatures (81°F) within a wide range (10°F) off the coast of Natal.

There is little doubt that wind, in particular northerly wind, plays an important part in bringing warm water close inshore, although the examination of local wind records in relation to attack has so far shown no obvious relationship. The work at present being carried out by the C.S.I.R. Oceanography Group on nearshore currents and circulation is providing valuable information on the extremely complicated relationship between meteorological conditions and nearshore circulation and it should be possible to define more clearly the relationship between these factors and shark attack once sufficient work has been done.

As far as is known, no sea temperatures were taken *in situ* immediately after shark attacks during the years preceding 1960. It is therefore of interest to examine the temperature data available for the Durban area (see Table 1) from which the relevant temperatures for

the months in which attacks took place have been extracted. These data are shown in Table B below.

TABLE B

Mean Temperatures recorded during the Month Immediately prior to and the Month in which Attacks took place, 1940-62

Year	Month*	Temperature in °F		
		Range	Mean	Mean for Previous Month
1940	Jan. (1)	70–78	74	74
	Feb. (1)	71–80	75	74
	Mar. (1)	71–79	76	75
	Dec. (1)	68–80	76	73
1941	—	—	—	—
1942	Nov. (1)	70–76	72	70
1943	Mar. (1)	72–78	76	77
1944	Jan. (2)	75–85	79	76
	Feb. (1)	72–82	77	79
	Mar. (3)	72–80	76	77
	Aug. (1)	72–78	70	68
1945	Mar. (1)	72–79	78	76
1946	Jan. (2)	70–78	75	74
	Feb. (2)	73–80	76	75
1947	Jan. (1)	72–76	75	74
	Mar. (2)	71–78	76	75
	Apr. (3)	72–78	74	75
	Jul. (1)	64–70	67	69
1948	—	—	—	—
1949	—	—	—	—
1950	Feb. (1)	71–79	76	75
	Mar. (1)	73–79	76	76
	May (1)	68–73	70	73
1951	Jan. (1)	68–73	71	70
	Feb. (1)	67–74	71	71
	Mar. (2)	68–75	72	71
	Nov. (2)	65–72	69	68
1952	—	—	—	—
1953	—	—	—	—
1954	Jan. (1)	71–78	74	74
	Dec. (1)	69–76	72	70
1955	—	—	—	—
1956	—	—	—	—
1957	Dec. (4)	70–78	73	72
1958	Jan. (1)	70–78	75	73
	Apr. (2)	70–76	73	73
1959	Feb. (1)	70–78	74	73
1960	Apr. (1)	70–75	73	75
	Dec. (1)	74–79	76	73
1961	Jan. (3)	78–80	78	76
	Dec. (1)	69–78	73	72
1962	Feb. (2)	73–81	75	75
	Apr. (1)	73–76	74	76

* Numbers of Attacks in Brackets

The temperature range recorded during the months in which attacks took place was 64-85°F. Mean temperatures during these months varied from 67°F to 79°F. The mean fell below 70°F on only two occasions, however, during July 1947 and in November 1951 and during both these months a maximum temperature of 70°F or higher was recorded. These data therefore support Coppleson's (1962) claim that 70°F is the critical temperature for shark attack on humans.

In the 11 cases for which temperatures were taken in situ immediately after the attack during the years 1960-62 the recorded temperatures ranged from 71-82°F (see Table A). This is again in conformity with Coppleson's critical temperature of 70°F.

Throughout the period 1940-62 mean maximum temperatures remained above 70°F (see Plate 1 and Table 1). During the period 1940-50, the year 1954 and the period 1956-61 average temperatures remained above 70°F. Coppleson's critical temperature of 70°F for shark attack could therefore be applied throughout the period as far as maximum temperatures are concerned and during the greater part of the period for mean temperatures.

The temperature range recorded during the period 1940-62 was considerable i.e. 60-85°F. Plate 1 shows graphically that considerable variation in the mean, minimum and maximum annual temperatures occurred during the period 1940-62. The years 1940-46 may be regarded as warm years during which maximum temperatures remained at 75°F or over, average temperatures remained at 72°F or over and minimum temperatures remained at 69°F. During the period 1947-53, temperatures fell more or less steadily to a lowest maximum of 70°F, an average of 68°F and a minimum of 65°F. Temperatures increased considerably during 1954 but fell sharply in 1955 when the lowest temperatures for the period were reached and then rose more or less steadily during the period 1955-61.

A general examination of temperatures in relation to the incidence of shark attack indicates that attacks were not confined to the warm years. It is of possible significance, however, that no attacks took place during the years 1953 and 1955 when the mean maximum temperature fell to 70°F and temperatures were generally low — 1955 being the coldest year during the entire period. Consideration of the incidence of attacks during this period is complicated by the fact that the protective nets were installed opposite the Durban beaches in 1952. The attacks shown in the histograms in Plate 1 are for Durban and the Natal coast.

The absence of attack in the years 1948 and 1949 is striking and it is of interest to note that little change in mean maximum or minimum temperatures took place during these years. No attacks took place in 1952 and 1953 when maximum and mean temperatures decreased and minimum temperatures for the two years remained the same. On the other hand, no attacks took place in 1955 or 1956 when temperatures underwent a sharp increase.

Wide differences in temperature were recorded for the years 1944 (warm) and 1955 (cold); the largest number of attacks during the period took place during 1944 and none took place during 1955. In view of these differences, records of the incidence of wind off the Durban beaches were obtained in order to find out whether any relationship between wind direction and water temperature could be found. The results of this comparison of wind and water temperature data were inconclusive but will be discussed in a later paper.

The mean temperature for each month during the period 1940-61 together with the total number of shark attacks that occurred in each month are shown in the table below:

TABLE C

Mean Temperatures and total number of attacks for each month, 1940-61.

Month	Mean Temperature	Total Number of attacks
	°F	
December ..	74	9
January ..	75	12
February ..	76	9
March ..	75	10
April ..	73	7
May ..	71	1
June ..	68	Nil
July ..	67	1
August ..	67	Nil
September ..	68	Nil
October ..	69	Nil
November ..	71	2

A high degree of correlation was found to exist between the mean monthly temperature and the total number of shark attacks that occurred in each month during the period (Corr. Coeff. 0.931). The relationship between mean temperature and the total number of attacks for each month during the period 1940-62 is shown graphically in Plate 2.

III. THE RELATIONSHIP BETWEEN SHARK ATTACK AND BEACH PATRONAGE

PRIOR TO 1940, shark attack off the Natal coast was not regarded as a serious problem and according to the available records the incidence of shark attack was very low indeed. It should be borne in

mind, however, that the recording and documentation of shark attack by newspapers, life-saving associations and other bodies was not nearly as good then as it is at the present time. This was no doubt partly due to the fact that the general system of coverage for news had not been developed to the same extent as it has today and due to the fact that less emphasis was placed on the sensational value of news prior to the outbreak of the second world war.

It is likely therefore, that records of shark attack for the Natal area are not complete and it is of interest to note that an entirely new record of a serious attack that took place at Winklespruit in 1934 was reported to the Institute for the first time in December, 1962. In spite of the possibility that documentation in relation to shark attacks on humans prior to 1940 is incomplete it seems unlikely that the incidence was as high at any time as it has been since 1940.

There is evidence that shark attack on humans off Durban was a well-known phenomenon as far back as 1907 when a special bathing enclosure was built off one of the main bathing beaches at Durban opposite the present Kenilworth Tea Room (see Fig. 3).

FIG. 3. The Old Bathing Enclosure, Durban

According to the records of the City Engineer, Durban, the reasons for constructing this enclosure were *to ensure that there was safe bathing*

and as a protection from shark attack. The enclosure was semi-circular in shape, had a diameter of 600 feet and was constructed of steel piles which had steel grids placed between them (see Fig. 4). The total cost at the time was R14,000. The enclosure was used until 1928 when it was decided that it should be demolished due to the damage it had suffered as a result of wave action and because of corrosion and the high cost of maintenance.

It seems therefore that, prior to 1940, shark attack took place off Durban and the Natal South Coast at an unknown but probably low rate of incidence and it is of interest to consider every possible factor in order to try to establish the reasons for the remarkable increase in the incidence of attack off the Durban beaches from 1940 until the installation of offshore nets in 1952 and off the Natal South Coast up to 1962.

FIG. 4. Construction used in the Old Bathing Enclosure, Durban

Among the various possible factors which may be related to this increased incidence of shark attack on humans is the greatly increased use of the sea as a recreational outlet. This development is not peculiar to South Africa but has taken place throughout the world wherever conditions of climate permit. This increased usage of the sea is related

to such factors as increasing population, improved methods of transport, shorter working hours and the increase of leisure time, greater familiarisation with the sea and everything in it as a result of the increased knowledge made available in a wealth of publications for the layman, the development of skin-diving, scuba-diving, spearfishing and angling, boating, surf-riding and a growing interest in the natural history of the sea-shore and coastal waters.

An increase in the utilisation of the sea off Durban and the Natal coast has been most marked in recent years and may be assessed with considerable accuracy by reference to the records of *beach patronage* kept by the Beach Manager for Durban's North and South beaches. Detailed records of the numbers of people who paid for the use of beach facilities such as changing booths have been made available for the period 1930-61 and they provide an excellent index of the extent to which the Durban beaches are patronised (see Table 2).

According to the information and figures provided by the Beach Manager, the development of Durban as a resort town began in 1939. Beach patronage for the period 1939-61 is shown graphically in Plate 3. It will be noted that considerable variation in beach patronage took place during the period 1939-61 due to such factors as the influx of Allied Forces personnel during the war years 1942-44, the spate of shark attacks that took place in 1944 and the poliomyelitis epidemics of 1945 and 1955. In spite of these variations, however, there is a marked upward trend in beach patronage which is well illustrated by the striking difference in the recorded patronage of 251,091 in 1939 and the maximal patronage for the period of 609,582 in 1957. This trend is also well shown in Plate 4 in which the mean patronage for five year periods has been calculated (Table 4). The patronage in 1961 was 507,519 and the decreased patronage since 1957 may be related to political and economic factors. According to the information available concerning the Natal South Coast resorts, the increased patronage of the Durban beaches is proportionately applicable to the South Coast from 1945 onward.

It is of interest to examine these data which provide an accurate record of the extent to which the Durban beaches have been used for recreational purposes during a period of thirty-two years and to attempt to relate them to the incidence of shark attack off Durban and the Natal coast.

In Plate 3 the patronage of the Durban beaches is expressed in total numbers of admissions to the bathing facilities per year for the period 1939-61 while the number of shark attacks per year for Durban and the South Coast are shown as histograms.

Examination of these data shows no obvious relationship between beach patronage and the incidence of shark attack on the Durban

beaches, the incidence of shark attack off the Natal South Coast *or* the total incidence of attack off the Natal coast. *It is evident, however, that the increased incidence of shark attack off the Natal coast in general is associated with an overall increase in beach patronage which began in 1940.*

The increase in the incidence of shark attack after 1940 was terminated by the installation of the nets off the Durban beaches in 1952 but attacks continued to take place off the South Coast. The increase in beach patronage from 1940 onwards is related to the general beach development and provision of additional amenities at that time, and the presence of large numbers of Allied Forces personnel during the war years. It is reasonable to state that the availability of humans to attacking sharks was greatly increased from 1940 onwards and when the other factors associated with attack were present the chances of attack were greatly increased from this time onwards.

The mean variation of beach patronage per month was calculated for the period 1955-61 and expressed as a percentage (see Table 3 and Plate 5). The period 1955-61 was chosen since an overall high patronage was recorded during these years. Comparison of the mean monthly beach patronage with the figures for the total incidence of shark attack per month during the period 1940-62 showed close agreement, the correlation coefficient being 0.850. *This shows that the months in which the largest numbers of people are making use of the sea are those in which the likelihood of shark attack is greatest.* Whether this is a function of the availability of humans to sharks or a function of temperature or some other factor is not certain.

The trend for the patronage of the Durban and Natal beaches to increase at a more or less steady rate as shown in Plate 4 is likely to continue due to the fact that the population of South Africa is increasing and due to the various factors mentioned earlier in this chapter which tend to favour the increased usage of the sea as a recreational outlet. The availability of humans to sharks is likely to become greater and the chances of attack are therefore likely to increase.

At the same time, however, the use of effective protective measures such as the offshore nets off Durban and the increasing awareness of the public that the persence of sharks off the Natal coast is a hazard has resulted in a change of attitude and an acceptance of the fact that there is a need to take precautions. These factors are likely to counter the increased chances of attack resulting from the presence of larger numbers of people in the water.

The long-term programme of research on sharks being carried out by the Oceanographic Research Institute and the Council for Scientific and Industrial Research is considered to be an important factor in relation to the alleviation and possible final solution of the problem of shark attack on humans.

IV. THE RELATIONSHIP BETWEEN SHARK ATTACK AND THE SEASONAL VARIATION IN THE ABUNDANCE OF DANGEROUS SHARKS

TWENTY shark attacks took place off the Durban beaches during the period 1944-51. As a result of this prolonged outbreak a protective system of nets was installed by the City Engineer in 1952. The system was based on similar installations already in use as anti-shark measures in Australia.

The principles of this protective system are by no means new, in fact it consists of nothing more than a double row of gill-nets laid opposite 11,000 feet of bathing beaches between the North Pier and the Country Club. There are altogether 25 nets, each of which is 450-500 feet in length and 20 feet deep and these are placed approximately 450 yards from the shore. A description of this system together with a plan of the general lay-out has appeared previously, Davies (1961). It is of interest to record that the City Engineer maintains a high standard of inspection and servicing of these nets and that no attacks have occurred off the Durban beaches since their installation in 1952 (time of writing March, 1963).

Apart from their effectiveness to date as an anti-shark measure, the nets have provided valuable data in relation to the incidence and seasonal variation in abundance of sharks off Durban and possibly off the Natal coast in general. Gill-netting is a well established and effective method for catching sharks and the Durban nets have thus provided a means of continuous sampling of the shark population. According to the catch returns (see Table 5) which show a marked decline after the first year, the nets have also proved most effective in reducing the shark population in the area off Durban.

One of the problems of interpretation of the shark meshing catches lies in the accurate identification of the sharks from the returns provided by the shark meshing boat. The names used by the crews are given in Table D shown overleaf.

It is evident that little or no confusion has arisen in respect of readily identifiable species such as the Tiger, Ragged-toothed and Blue Pointer. No distinction has been made between two species of Mako, Hammerhead and Blackfin and the distinction made between Lazy Grey and Grey Sharks is likely to be invalid according to comparisons of boat records with subsequent identification of the same specimens. These discrepancies are not considered to be serious in the light of what is now known about the occurrence of dangerous sharks off Natal.

In 1959 a taxonomic survey of the sharks of the Natal region was begun by this Institute. The area of the survey was later extended to include the entire east coast of South Africa as well as oceanic species. A great deal of material has been obtained from the shark nets and it is on the basis of the examination of this material that the approximate indications of the relative abundance of the different species of *Sphyrna* and *Carcharinus* have been given in the table below:

TABLE D

Reliability of Common Names used in Shark Meshing Operations

Name used by Shark Boat Crews	Scientific Name	Reliability of Identification
Mako	*Isurus oxyrhynchus* or *Isurus glaucus*	Good (for the genus only)
Tiger	*Galeocerdo cuvieri*	Good
Ragged-toothed Shark	*Carcharias taurus*	,,
Blue Pointer ..	*Carcharodon carcharias*	,,
Hammerhead ..	*Sphyrna diplana* (majority) *S.tudes* (v. few)	No distinction made between species
Blackfin	*Carcharinus limbatus* (majority) *C.maculipinnis* (v. few)	No distinction made between species
Lazy Grey	*Carcharinus zambezensis* (majority)	No distinction made between species
Grey	*C.van rooyeni* (v. few) *Carcharinus* with ridge (rare)	

The survey has so far shown that 24 species of shark occur off the coast of Natal. Of these, the following are potentially dangerous or dangerous to man according to evidence from Natal and other parts of the world:

Ragged-toothed Shark *Carcharias taurus* Rafinesque
Zambezi River Shark *Carcharinus zambezensis* Peters
Blue Pointer *Carcharodon carcharias* (Linnaeus)
Tiger Shark *Galeocerdo cuvieri* (Leseur)
Hammerhead *Sphyrna* sp.

As far as is known, one species of shark alone has so far been *proved* to attack man in the Natal area. Definite evidence was obtained in December, 1960, in the form of tooth fragments extracted from the femur of a fatally injured African who was attacked at Margate (see Fig. 2). These fragments were matched with teeth in specimen jaws of the Zambezi River Shark *C.zambezensis* also known as the Shovel-

nosed Grey in the collection of jaws at the Oceanographic Research Institute, Davies and d'Aubrey (1961).

An earlier investigation of the wounds of M.H., a victim of shark attack, by Campbell, Davies and Copley (1960) provided convincing evidence in the form of characteristic bony lesions in the hip bone (iliac crest) of the victim, caused by the teeth and favouring the incrimination of the Ragged-toothed Shark *Carcharias taurus*. Since then, thirteen cases have been investigated and considerable experience gained in the interpretation of injuries in relation to the species of shark responsible. A re-examination of the hip, leg and arm injuries of the victim has shown that it is most unlikely that the shark responsible was *C.taurus* and that it was almost certainly a Zambezi River Shark *Carcharinus zambezensis*. The reasons for this change in opinion on the part of one author (Davies) are that the shape and general deposition of skin lesions on the right leg of M.H. are characteristic of the lesions made by the flattened, serrated, cutting teeth of a Carcharinid rather than the elongated, smooth, pointed teeth of *C.taurus*. The skin lesions at the knee are typical of those caused by Carcharinid teeth. The deep, narrow bony lesions in the right iliac crest which at first seemed to provide such convincing evidence of having been made by the elongated, smooth teeth of *C.taurus* could have been made by the triangular teeth of a Carcharinid moved sideways, edge-on across the iliac crest.

Other evidence, although admittedly circumstantial, tends to favour the exoneration of *C.taurus* as a species dangerous to man; for example specimens of *C.taurus* kept in the Durban Aquarium for nearly two years were sluggish and docile in their habits while *C.zambezensis* of similar size were aggressive and offensive at all times. *C.taurus* has not been proved to have attacked humans in other parts of the world according to Bigelow and Schroeder (1948), although it is mentioned that this species *may be dangerous* in the eastern Indian Ocean.

It seems therefore that the *RAGGED-TOOTHED SHARK C.taurus* should be rated as a species of *possible* danger to man. In this connection it is of interest to consider the catch returns of Ragged-toothed Sharks in the Durban nets (see Table 6 and Plate 6, Fig. 1).

The total catch of *C.taurus* for the ten year period 1952-61 was 251 sharks and the annual catch varied from a maximum of 67 in the first year to a minimum of 9 in 1960. Catches were higher for most species during the first year of operation of the nets and for this reason and because 1952 was not a complete year for meshing the mean monthly catch returns shown in the graphs (see Plate 6, Fig. 1) have been based on the period 1953-61 for all species.

There is considerable variation in the catches of *C.taurus* in relation to season — they are present in largest numbers in mid-spring and early summer during the months October-December. The majority

caught in the nets are females of large size (over 2,500 mm. in total length). Between February and June they are almost entirely absent from the catches but begin to appear again in July and increase in number through to November which is the peak month. It is interesting to note that November is a month of relatively low incidence of shark attack in Natal. During the period 1940-62 only three attacks took place in November, an attack at Umkomaas in 1942, one at Winklespruit in 1951 and an attack at Durban in 1951.

The ZAMBEZI RIVER SHARK, C.zambezensis (known also as the Shovelnosed Grey) is included in the two categories Lazy Grey and Grey used by the shark meshing teams and this species constitutes the majority of sharks classified under these two names according to the examination of specimens obtained from the catches since 1959. The total catch for the ten year period 1952-61 was 569 sharks and the annual catch varied from a maximum of 139 in the first year to a minimum of 32 in 1954, the total catch in 1961 being 39 (see Table 7 and Plate 6, Fig. 2).

It is likely that only two other species have been included in the catch returns under the heading of Grey Sharks. These are *Carcharinus van rooyeni* Smith a species very close to *C.zambezensis* and *Carcharinus* sp. a similarly heavy-headed shark but differing clearly in possessing a dorsal ridge. A detailed comparison using descriptions and original data was made by d'Aubrey of *C.van rooyeni*, *C.nicaraguensis*, *C.leucas* (the American Bull Shark) and *C.zambezensis* and the differences listed, Davies and d'Aubrey (1961). Although no important differences were found it was felt that it would be easier to clarify the situation finally when more material had been obtained. Since then, *C.nicaraguensis* has been found to be synonymous with *C.leucas* by Bigelow and Schroeder (1961) and a great deal of additional material has been examined in this Institute. The results of these investigations are in the course of preparation, d'Aubrey (1963).

Fourmanoir (1961) has recently described two sharks from the Madagascar region as *Carcharinus iranzae* and *C.leucas* and states that the former species together with *C.gangeticus*, *C.zambezensis* and *C.greyi* could be variations of *C.leucas*. He states that *C.leucas* is found at Nosy-Bé during the rainy season and mentions its euryhaline characteristics.

Before dealing with the catch returns of the shark boat for this species it is of interest to note that large numbers of *C.zambezensis* enter the estuary at St. Lucia (see Fig. 2) during late spring and summer. Among the sharks caught at the estuary are female *C.zambezensis* bearing young and during November and December 1962, ten recently-born juvenile *C.zambezensis* (with obvious scars from the yolk-sac placenta) were caught in an area known as the Third Narrows, approximately 8 miles from the sea in water of salinity $<20‰$. In addition,

large numbers of small *C.zambezensis* were seen breaking the surface of the water throughout the two month period at St. Lucia.

It is likely that *C.zambezensis* are born in estuaries (or enter estuaries soon after birth) and juveniles spend considerable periods in rivers since small specimens have been recorded in fresh water many (up to 300) miles from the sea in the Limpopo, Sabi and Zambezi River Systems, Jubb (1961). It is possible that this species remains in fresh or brackish water for long periods and then migrates to the sea. *C.zambezensis* is a coastal species and large specimens (100 lbs. and over) are regularly caught from the beach by surf anglers during the summer months off the coast of Natal.

Considerable numbers of large *C.zambezensis* (200-400 lbs. weight) have been seen in shallow water at St. Lucia estuary during the summer months. These sharks congregate at times in the shallows where they refuse to take any bait but have been identified after having been speared. At other times they swim about the estuary often with dorsal fins above the surface (see Fig. 5) and will sometimes take a bait.

Fig. 5. Dorsal Fin of Zambezi River Shark in St. Lucia Estuary, December, 1962

During January, 1963, large numbers of sharks were seen by three canoeists on the Limpopo River between Guija (120 miles inland) and the coast at Xai Xai in Moçambique. In areas of deep water on

the river, sharks of large size (certain specimens were estimated to have reached up to 8 feet in length against the length of the canoes) behaved in a most aggresive manner. The sharks swam repeatedly up to the canoes bumping against the undersides of each canoe with their noses and backs. A shark attacked one of the canoes, biting through the fabric and causing its occupant, a student of the University of Cape Town named Jopie Overes, to paddle for the bank as fast as possible in order to reach safety before his canoe sank (personal communication: Willem van Riet, one of the canoeists).

There can be little doubt that the sharks responsible for these attacks on the canoes were Zambezi River Sharks since no other species is known to penetrate rivers to this extent off the east coast of South Africa and since the description of the sharks given by Willem van Riet agrees well with that of *C.zambezensis*. It is likely therefore, that this species spends considerable periods in freshwater and it is not impossible that *C.zambezensis* spends the greater part of its life in rivers and estuaries. Heavy rains resulting in the flooding of rivers may attract this species from rivers into coastal waters.

This general information concerning *C.zambezensis* leads to interesting speculation concerning the possible migration of the species in South African waters. An examination of the catch returns for Grey Sharks caught in the Durban nets (see Table 7 and Plate 6, Fig. 2) provides additional information.

The total catch for the ten year period 1952-61 consisted of 569 sharks — higher than any other group caught in the nets. The annual catch varied from a maximum of 139 in 1952 to a minimum of 32 in 1954. Thirty-nine sharks were caught in 1961.

Catches of Grey Sharks show marked seasonal variation (see Plate 6, Fig. 2) and are lowest from mid-autumn (April) through winter to spring. An increase takes place in October and continues, reaching a maximum in mid-summer (January). During February and March catches remain good but decline sharply in April. Records of total numbers of specimens of *C.zambezensis* received by the Institute since 1959, show a similar variation of occurrence in relation to season and consist of males and females mainly of large size 1000-2000 mm. in total length.

The total number of shark attacks recorded per month for the period 1940-62 off the Natal coast was plotted together with the graph showing the abundance of Grey Sharks (see Plate 6, Fig. 2). From these graphs it is evident that *the period of increasing and maximum abundance of C.zambensis coincides closely with the seasonal increase in the incidence of shark attack*. Further reference is made to this and other factors in Chapter 6.

The BLUE POINTER, Carcharodon carcharias is known as the Great White Shark in the U.S.A. and by various other names in different

parts of the world. *C.carcharias* is a large species that is known to attack man and boats and should be regarded as a dangerous species wherever it is found.

Catch returns for *C.carcharias* for the ten year period 1952-61 (see Table 8) showed that a total of 103 sharks were caught and that the annual catch varied from a maximum of 14 in the first year to a minimum of 3 in 1961. Mean monthly catches for the period 1953-61 were less than 1 for seven months of the year, between 1 and 2 for four months and the highest average of 2.3 for September. *There seems to be little indication that the incidence of C.carcharias is related to attack on humans unless further evidence in favour of the "rogue shark theory", is forthcoming, Coppleson (1962). Although C.carcharias is caught by shark fishermen from the South Pier, this species is generally regarded as being oceanic rather than coastal and specimens weighing up to 3,000 lbs. have been caught in the whaling grounds approximately 100 miles off Durban.*

The *TIGER SHARK, Galeocerdo cuvieri* is regarded as a dangerous species and while there is much evidence that it will eat human remains there seems to be little positive evidence that it attacks living humans.

The total catch for Tiger Sharks for the period 1952-61 was 13 (see Table 9) indicating that this species is rare in inshore waters off Durban. According to Bigelow and Schroeder (1948) the Tiger Shark is widespread in the tropical and sub-tropical zones of all oceans both inshore and offshore and is found south of Durban, Smith (1961). It would appear from the small numbers caught in the nets that Durban is nearing the southerly limit of distribution for this species in this area. *The low incidence of Tiger Sharks off Natal as reflected by the catches in the Durban nets suggests that this species is unlikely to be responsible for attacks on bathers.*

As *HAMMERHEAD SHARKS* are dangerous to man according to Bigelow and Schroeder (1948), some consideration of the catches in the Durban nets should be given. According to the specimens received from the nets by the Institute two species of hammerhead are caught viz. *Sphyrna diplana* and *S.tudes*. *S.diplana* is frequently caught off Durban and *S.tudes* is relatively rare.

A total of 500 Hammerheads was caught in the nets during the ten year period 1952-61 (see Table 10) showing that they are among the three most abundant sharks in the area (Grey Sharks 569, Blackfin 535 for the same period). The annual catches varied from a maximum of 107 in 1953 to a minimum of 23 in 1959 as well as in 1960 (see Plate 7, Fig. 1).

The incidence of hammerheads is subject to considerable variation in relation to season and it is interesting to note that they are present in greatest numbers in the catches during the month of January although this is not necessarily true for every year, for example 1961. The seasonal variation in the abundance of *Sphyrna* varies in a manner very similar to that of the Grey Sharks (see Plate 6, Fig. 2) and thus

coincides closely with the incidence of shark attack off the coast of Natal.

There is no evidence that *Sphyrna* has ever attacked or threatened to attack bathers or divers in the Natal area. Attacking sharks seen by witnesses have all been reported as "Grey Sharks" and at no time has the obvious shape of the head of a Hammerhead been recognised. Since *Sphyrna* is one of the most easily recognisable sharks and as the majority of Hammerheads caught in inshore waters in Natal are of relatively small size *it seems most unlikely that Hammerhead Sharks are responsible for attack on humans in Natal in spite of their numbers and their relative abundance during periods when most attacks take place.*

BLACKFIN SHARKS include at least two species, *Carcharinus limbatus* and *C.maculipinnis*. According to specimens received from the nets and examined in the Institute it is likely that the majority of Blackfins caught in the Durban nets are *C.limbatus* (47 specimens) against 6 specimens of *C.maculipinnis*).

Blackfin are the most numerous sharks caught in the nets apart from Grey Sharks. During the ten year period 1952-61 a total catch return of 535 Blackfin was made, the largest number caught being 134 in 1952 and a minimum catch of 13 in 1961 (see Table 11).

Seasonal variation in abundance is difficult to interpret in relation to the catch returns (see Plate 7, Fig. 2) which show a maximum in January (mid-summer), June (early winter) and a sub-maximum in March (early autumn). It seems likely that the position is confused by the presence of the two species and it is possible that there is a summer maximum for one species and a winter maximum for the other although Institute records do not support this idea and show that the largest numbers of *C.limbatus* were received in February, August and December. Once again, the abundance of Blackfin in summer coincides with the highest incidence of shark attacks. Although *C.limbatus* is not regarded as a dangerous species and small specimens kept in the Durban Aquarium are generally nervous and quite non-aggressive, the possibility that the Blackfin would attack humans cannot be entirely ruled out. *C.maculipinnis* is suspected of having attacked humans, Bigelow and Schroeder (1948), but the evidence in this single instance is extremely thin. *It is considered to be unlikely but not impossible that Blackfin Sharks are responsible for attacks on humans in Natal waters in spite of their relative abundance during the periods when the incidence of attacks is high.*

MAKO SHARKS include two species *Isurus oxyrhynchus* and *I.glaucus* and are extremely rare in inshore waters in Natal according to the shark boat catches.

Only 3 Makos were caught during the ten year period 1952-61 and *although Isurus is a ferocious shark which is listed as dangerous by Coppleson (1962) it is considered most unlikely that this species has been responsible for attacking humans off the coast of Natal.*

V. SUMMARY

AN INVESTIGATION of shark attack and its relationship to sea temperature, beach patronage (which provides an index of the numbers of people using the sea for purposes of recreation) and the seasonal variation in the abundance of dangerous sharks off Durban and the Natal coast was carried out. The findings resulting from this investigation are given as follows:

1. There is evidence that considerable changes in sea temperature occur off Durban. The temperature range recorded during the period 1940-62 was 60-85°F. There may be long periods during which temperatures remain relatively high such as the period 1940-46, referred to as *the warm years*. There may be sudden drops in temperature producing relatively cold years such as 1955 and equally sudden increases in temperature may take place as in 1956. It is possible that these changes may be related to wind but comparison of certain wind data provided no evidence in this connection. Shark attacks took place during warm and cool periods but did not take place during the coldest year, 1955.

2. In the eleven cases for which accurate sea temperatures were taken *in situ* immediately following a shark attack the temperature range was 71-82°F. This evidence together with the evidence provided by a detailed investigation of all the available temperature data confirms Coppleson's claim that 70°F is the critical temperature for shark attack on humans. The possibility nevertheless remains that attacks may take place in this area at temperatures below 70°F.

3. An analysis of the relationship between the mean monthly temperatures for the period 1940-61 and the total number of attacks recorded for each month for the entire period showed a high degree of positive correlation. Temperature may therefore be regarded as an important factor in the incidence of shark attack on humans.

4. Due to the increased utilisation of the sea for recreational purposes, the availability of humans to sharks off the Natal coast has increased steadily since 1940 when a general increase in the incidence of shark attack began.

5. There is a high degree of correlation between the mean monthly beach patronage and the recorded incidence of shark attack.

6. The protective system of offshore netting off the Durban beaches installed in 1952 has had an excellent record of success as no attacks have taken place off the protected beaches since the year of installation.

7. The offshore nets have provided an effective means of sampling the shark population off the Durban beaches and eleven species of shark have been recorded among the catches.

8. So far, one species of shark, *Carcharinus zambezensis* the Zambezi River Shark also known as the Shovelnosed Grey or Slipway Grey has been proved to attack humans off the Natal coast. It is likely that this species has been responsible for the majority of the attacks off Natal.

9. Zambezi River Sharks and newly-born young are present in the St. Lucia estuary during the summer. It is likely that females enter the estuary and give birth to their young in October-November each year. The young sharks remain in the estuary and farther up the lake system in fresh water for many months.

10. The period of increasing and maximum abundance of the Zambezi River Shark off the Natal coast coincides closely with the recorded incidence of shark attack on humans.

11. The incidence of Tiger Sharks *Galeocerdo cuvieri* in inshore waters off Durban is low according to the catch returns for the nets and it is unlikely that this species has been responsible for attacks on bathers.

12. Although Hammerhead Sharks, *Sphyrna* sp. are abundant during periods of high incidence of shark attack it is unlikely that the two species recorded have been responsible for attacks on humans off Natal.

13. Blackfin Sharks, *C.limbatus* and, to a lesser extent, *C.maculipinnis* are abundant during periods of high incidence of shark attack. It is considered unlikely but not impossible that Blackfin have been responsible for attacks on humans in Natal waters.

14. The Blue Pointer Shark, *Carcharodon carcharias* has been proved to attack humans in other parts of the world but this species does not appear to be common in inshore waters off Natal and so far there is no evidence that it has been responsible for attacking humans in this area.

15. The Mako Shark, *Isurus* sp. is a dangerous species which appears to be rare in inshore waters off Natal. It is unlikely that it has been responsible for attacking humans in this area.

16. According to the records of shark attack for the period 1940-62 off the coast of Natal, the highest number of attacks took place in the months December to April, a single attack took place in each of the months May and July and the months August to November were entirely free from attack.

VI. ACKNOWLEDGEMENTS

GRATEFUL acknowledgement is made to Mr. A. Kinmont, City Engineer, Durban, for making available the catch returns of the shark meshing operations off Durban; Mr. N. Lawrence, Beach Manager, Durban, for making available temperature and weather data and the figures for beach patronage; Mrs. D. Strutt, Director of the Old House Museum, for the photographs of the Old Bathing Enclosure at Durban; Mr. K. Cooper for the photograph of the dorsal fin of the shark at St. Lucia; the S.A. Lifesaving Association for certain of the sea temperatures recorded after shark attack and for the co-operation of their members in many other ways.

The Taxonomic Survey of the sharks found off the East Coast of South Africa is of basic importance to every aspect of the Shark Research Programme. The financial support for this Survey received from the Council for Scientific and Industrial Research, Pretoria, is gratefully acknowledged.

I am indebted to Miss J. d'Aubrey for critical reading of the manuscript and to Miss R. Ahrens for assistance in the preparation of the figures and plates.

VII. LITERATURE CITED

BIGELOW, HENRY B. and WILLIAM C. SCHROEDER. 1948. Fishes the of Western North Atlantic. Pt. I. Mem. Sears Found. Mar. Res. 1: pp. 1-576.

BIGELOW, HENRY B. and WILLIAM C. SCHROEDER. 1961. *Carchinus nicaraguensis*, A Synonym of the Bull Shark, *C.leucas*. Copeia, No. 3. p. 359.

CAMPBELL, G. D., D. H. DAVIES and A. C. COPLEY. 1960. A Case of Shark Attack. Medical Proceedings, Vol. 6, No. 26, pp. 612-621. Cape Town.

COPPLESON, V. M. 1962. Shark Attack, 1-266. Sydney.

D'AUBREY, JEANNETTE, D. 1963. The Zambezi River Shark, *C.zambezensis*. In preparation.

DAVIES, D. H. 1961. Description of Shark Meshing at Durban (The Shark Problem). S.A. Association for Marine Biological Research, Bull. No. 2, pp. 23-27. Durban.

DAVIES, D. H. 1962. The Shark Problem. The South African Journal of Science. Vol. 58, No. 9, 253-258. Johannesburg.

DAVIES, D. H. and CAMPBELL, G. D. 1962. The Aetiology, Clinical Pathology and Treatment of Shark Attack. Journal of the Royal Naval Medical Service, vol. XLVIII, No. 3, 110-135. Hampshire.

DAVIES, D. H. and J. D. D'AUBREY. 1961. Shark Attack off the East Coast of South Africa, 24 December, 1960, with Notes on the Species of Shark responsible for the Attack. Investigational Report No. 2, Oceanographic Research Institute, pp. 1-8. Durban.

FOURMANOIR, P. 1961. Requins de la Cote ouest de Madagascar. Memoires de l'Institut Scientifique de Madagascar. Serie F., Tome IV, pp. 1-81.

JUBB, REX A. 1961. Freshwater Fishes of the Zambezi River, Lake Kariba, Pungwe, Sabi, Lundi and Limpopo Rivers. pp. 1-171. Bulawayo.

SCHULTZ, LEONARD P. 1958. World Shark Attack File (in preparation). U.S. Nat. Mus., Dept. of Fishes, Washington, D.C.

SCHULTZ, LEONARD P., PERRY W. GILBERT and STEWART SPRINGER. 1961. Shark Attacks, Science, July 14, Vol. 134, No. 3472, pp. 87-88.

SMITH, J. L. B. 1961. The Sea Fishes of Southern Africa. pp. 1-580. Cape Town.

TABLE 1

MEAN MONTHLY TEMPERATURES TAKEN AT NORTH BEACH, DURBAN, 1937-62

	1937		1938		1939		1940		1941		1942		1943		1944		1945	
Month	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
J	70–79	74	69–76	74	70–78	75	70–78	74	68–80	73	75-80	78	73–80	77	75–85	79	72–80	76
F	75–80	77	73-79	76	73–80	76	71-80	75	70–80	77	71-80	78	70–80	77	72–82	77	73–82	78
M	70–78	76	70–78	74	70–78	74	71–79	76	72–79	76	77-80	78	74–79	76	72–80	76	72–79	76
A	70–78	75	68–76	73	69–76	73	70–76	74	67–79	76	72–79	75	70–77	74	72–78	76	70–78	75
M	68–74	71	69–75	72	70–75	73	70–74	72	70–76	74	66–76	73	68–74	71	66–74	70	67–75	72
J	66–76	71	65–72	70	66–72	69	68–72	69	68–74	71	67-72	70	66–70	68	66–73	69	64–71	68
J	65–71	68	64–70	68	65–70	68	65–70	68	66–71	69	65–71	68	64–70	68	64-72	68	68–71	69
A	62–71	67	63–70	67	65-69	67	67–71	69	67–72	69	66–71	69	64-70	68	68–72	70	65–71	68
S	65–71	68	64–73	68	62–70	67	68–72	70	66–72	69	66–73	69	66–71	68	67–73	69	68–74*	70
O	66–74	70	66–70	69	67–74	70	67–76	71	70–77	72	68–75	70	68–77	70	68–74	71	76–72	70
N	66–73	71	67–73	71	69–75	72	70–75	73	71–77	75	70–76	72	69–80	74	71–74	73	70–75	72
D	72–76	73	70–76	73	72-77	74	69–80	76	73–78	76	68–77	74	72–82	76	72–78	75	71–76	74

TABLE 1

MEAN MONTHLY TEMPERATURES TAKEN AT NORTH BEACH, DURBAN, 1937-62

	1946		1947		1948		1949		1950		1951		1952		1953		1954	
Month	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
J	70–78	75	72–76	75	70–77	73	72–76	75	70–77	75	68–73	71	69–75	73	71–75	73	71–78	74
F	73–80	76	68–80	76	70–80	75	74–78	76	71–79	76	67–74	71	69–76	74	71–75	73	75–80	78
M	72–79	76	71–78	76	70–78	74	71–77	73	73–79	76	68–75	72	69–76	74	67–74	70	68–77	74
A	72–77	75	72–78	74	71–76	72	67–75	73	71–76	73	69–73	71	68–74	72	65–71	68	71–76	73
M	68–73	71	68–73	71	69–74	71	66–73	70	68–73	70	67–72	69	66–72	69	66–68	67	76–72	70
J	66–70	69	67–72	69	66–72	69	66–70	68	66–70	68	61–68	65	60–67	66	61–66	64	65–70	67
J	66–71	69	64–70	67	62–68	66	65–69	67	65–72	68	62–66	64	63–66	65	58–65	62	62–70	66
A	65–70	69	66–70	68	64–71	68	67–70	68	63–68	66	62–65	63	61–67	64	60–64	62	64–68	66
S	68–72	70	65–72	68	65–71	68	66–70	68	63–72	67	60–69	66	62–67	66	61–66	63	66–70	68
O	69–74	71	68–72	70	70–72	71	68–71	69	66–70	68	66–71	68	63–69	66	63-67	65	66–71	69
N	70–75	72	70–79	73	69–73	72	68–73	70	66–71	69	65–72	69	65–70	68	66-75	69	63-73	70
D	70–78	74	70–76	73	70–77	75	70–76	73	68–74	70	69–73	71	65–72	69	70–77	74	69–76	72

TABLE 1

MEAN MONTHLY TEMPERATURES TAKEN AT NORTH BEACH, DURBAN, 1937-62

	1955		1956		1957		1958		1959		1960		1961		1962	
Month	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
J	70–75	73	67–75	72	72–78	76	70–78	75	71–79	75	73–82	76	76–81	78	72–77	75
F	68–77	73	74–79	76	70–78	75	72–79	76	70–78	74	71–81	76	78–80	78	73–81	76
M	65–75	71	75–79	77	75–78	76	72–77	75	70–79	74	72–79	75	75–80	78	74–77	76
A	66–72	69	67–76	72	71–76	74	70–76	73	58–75	73	70–75	73	74–78	76	73–76	74
M	62–69	66	67 74	70	69–74	72	70–74	72	68–73	70	69–73	70	72–76	74	67–74	73
J	62–66	64	66–71	68	64–70	68	66–72	69	69–72	70	69–70	70	69–73	71	67–73	71
J	59–63	61	66–69	67	66–69	68	67–69	69	68–70	69	68–70	69	67–72	69	67–70	69
A	62–64	64	67–71	69	66–69	68	65–72	67	68–71	70	68–70	69	66–71	68	62–72	68
S	60–64	62	63–72	69	64–73	68	66–70	68	69–75	71	67–71	69	66–70	68	65–74	71
O	61–65	64	67–73	70	68–72	71	67–71	69	69–75	71	68–72	70	67–74	70	70–73	71
N	60–68	64	71–74	73	70–74	72	69–72	71	70–75	72	70–76	73	71–75	72	71–75	73
D	63–76	71	71–75	74	70–78	73	72–78	74	71–77	74	74–79	76	69–78	73	73–78	75

TABLE 2

PATRONAGE OF DURBAN BEACHES 1930-61

Year ..	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
	127,066	159,811	184,005	192,494	170,345	152,318	125,529	159,528	239,752	251,091	264,099	315,002	358,498	309,122	319,498
Year ..	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
	296,080	417,214	391,545	389,822	411,065	439,120	417,529	436,195	433,907	435,367	337,354	528,089	609,582	545,091	556,559
Year ..	1960	1961													
	557,862	507,519													

GROSS TOTAL 3,642,056

TABLE 3

Mean monthly Patronage of Durban Beaches for the Period 1955-61 together with the Total Number of Attacks per Month for the period 1940-62.

Month	Percentage	Total Number of Attacks per Month 1940-62
Jan. ..	16	12
Feb. ..	10	9
Mar. ..	10	10
Apr. ..	10	7
May ..	6	1
June ..	3	0
July ..	9	1
Aug. ..	2	0
Sept. ..	4	0
Oct. ..	6	0
Nov. ..	6	2
Dec. ..	18	9

Conversion Table Fahrenheit to Centigrade

°F	°C
59.0	15
60.8	16
62.6	17
64.4	18
66.2	19
68.0	20
69.8	21
71.6	22
73.4	23
75.2	24
77.0	25
78.8	26
80.6	27
82.4	28
84.2	29
86.0	30
87.8	31
89.6	32
91.4	33
93.2	34
95.0	35
96.8	36
98.6	37
100.4	38

TABLE 4

Mean Patronage of Durban Beaches for Five-year Periods, 1930-61

1930-31	1932-36	1937-41	1942-46	1947-51	1952-56	1957-61
143,439	164,938	245,894	340,084	409,816	434,182	555,323

TABLE 5

SHARKS CAUGHT IN MESHING OPERATIONS OFF DURBAN, 1952-61

Year	Mako *Isurus glaucus*	Tiger *Galeocerdo cuvieri*	Ragged Tooth *Carcharias taurus*	Blue Pointer *Carcharodon carcharias*	Hammerhead *Sphyrna* spp.	Blackfin *Carcarhinus* sp.	Lazy Grey *Carcarhinus* sp.	Grey *Carcarhinus* spp.
1952	—	2	69	15	141	170	20	135
1953	—	1	11	15	63	46	5	43
1954	—	—	22	8	79	48	7	31
1955	2	2	39	10	40	27	—	38
1956	—	1	9	7	29	46	—	50
1957	—	—	13	6	34	30	—	57
1958	—	4	32	22	31	69	3	64
1959	—	1	31	8	20	48	4	53
1960	—	—	9	7	22	36	6	37
1961	1	1	12	12	30	35	6	34
Total	3	12	247	110	489	555	51	542

TABLE 6

Catches of Ragged Toothed Sharks off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Mean 1952-61	Mean 1953-61
Jan.	—	4	3	1	4	—	—	—	-	-	1.2	1.4
Feb.	—	—	—	—	—	—	—	—	—	—	—	—
Mar.	—	—	—	1	—	—	1	—	1	-	0 3	—
Apr.	—	—	—	—	—	2	—	—	—	—	0.2	—
May	-	—	—	—	1	—	—	—	1	—	0 2	—
June	-	—	—	—	—	—	—	—	—	1	0.1	—
July	3	—	—	1	—	1	—	4	—	—	0.9	0 7
Aug.	4	1	—	—	1	—	7	—	—	—	1.3	1.0
Sept.	—	—	1	3	—	2	3	—	4	2	1 5	1.7
Oct.	29	3	4	3	1	4	8	3	3	—	5.8	3 2
Nov.	15	5	14	13	3	3	11	20	—	5	8.9	8 2
Dec.	16	—	3	16	3	3	2	—	—	4	4.7	3 4
Total ..	67	13	25	38	13	15	32	27	9	12		

TABLE 7

Catches of Grey Sharks off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Mean 1952-61	Mean 1953-61
Jan.	—	27	7	13	10	6	4	4	4	5	8.8	8.8
Feb.	—	8	—	4	6	8	9	2	5	2	4 9	4.9
Mar.	39	2	2	5	5	9	9	6	9	3	8 9	5.6
Apr.	32	4	—	5	3	3	4	7	1	—	5.9	3 0
May	5	4	1	3	3	1	2	1	1	—	2 1	1.8
June	11	—	2	3	5	2	2	3	—	9	3.7	2.9
July	13	1	1	—	1	1	8	4	1	8	3.8	2 8
Aug. ..	3	2	1	2	1	2	1	6	—	1	1.9	1.8
Sept.	—	—	—	1	3	1	3	6	2	1	1.7	1.9
Oct.	11	4	1	1	—	8	5	6	7	1	4 4	3.7
Nov.	11	2	8	3	8	6	2	2	5	1	4.8	4.1
Dec.	14	6	9	4	6	6	10	5	5	8	7.3	6.6
Total ..	139	60	32	44	51	53	59	52	40	39		

TABLE 8

Catches of Blue Pointers off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Mean 1952-61	Mean 1953-61
Jan.	—	1	2	2	—	—	—	—	—	—	0.5	0.6
Feb.	—	—	—	—	1	—	—	—	1	—	0.2	0.3
Mar.	1	—	2	—	—	—	—	—	—	—	0.3	0.2
Apr.	—	—	—	1	—	—	—	—	—	—	0.1	0.1
May	—	3	—	—	1	—	1	5	—	—	1.0	1.1
June	2	1	1	—	1	1	3	—	—	1	1.0	0.9
July	1	1	—	—	1	1	2	3	—	1	1.0	1.0
Aug.	2	3	1	—	—	—	2	—	—	—	0.8	0.7
Sept.	5	2	4	3	2	1	6	—	2	1	2.6	2.3
Oct.	—	—	—	2	1	—	7	—	3	—	1.3	1.4
Nov.	3	2	—	—	—	3	2	1	1	—	1.2	1.0
Dec.	—	1	—	2	—	—	—	—	—	—	0.3	0.3
Total ..	14	14	10	10	7	6	23	9	7	3		

TABLE 9

Catches of Tiger Sharks off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Jan.	—	—	—	—	—	—	—	—	—	—
Feb.	—	1	—	—	—	—	—	—	—	—
Mar.	—	—	—	—	—	—	—	—	—	—
Apr.	—	—	—	—	—	—	—	—	—	—
May	1	—	—	—	—	—	—	—	—	—
June	—	—	—	—	—	—	—	—	—	—
July ..	2	—	—	—	—	—	2	—	—	—
Aug. ..	—	—	—	—	—	—	—	—	—	—
Sept.	—	—	—	1	—	—	1	—	—	—
Oct.	—	—	—	1	—	—	1	—	—	—
Nov.	—	—	—	—	—	—	—	1	—	1
Dec.	—	—	—	—	1	—	—	—	—	—
Total ..	3	1	—	2	1	—	4	1	—	1

TABLE 10

Catches of Hammerheads off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Mean 1952-61	Mean 1953-61
Jan.	—	52	6	27	12	3	3	6	3	1	—	12.5
Feb.	—	7	—	1	5	5	2	—	—	3	—	2.9
Mar.	13	4	15	1	12	—	4	—	4	3	5.6	6.2
Apr.	8	14	4	5	1	3	—	2	—	—	3.7	3.2
May	6	2	9	—	1	—	7	—	—	2	2.7	2.3
June	13	3	7	1	3	5	2	2	3	3	4.2	3.2
July ..	9	4	3	—	—	1	1	—	1	10	2.9	2.2
Aug.	8	8	4	—	1	3	—	2	—	—	2.6	2.0
Sept.	15	1	3	4	—	7	2	2	—	1	3.5	2.2
Oct.	3	6	4	1	—	1	5	—	7	1	2.8	2.7
Nov.	12	1	6	—	1	3	6	3	3	—	3.5	2.6
Dec.	8	5	13	—	4	5	—	6	2	6	4.9	4.5
Total ..	95	107	74	40	40	36	32	23	23	30		

TABLE 11

Catches of Blackfin off Durban Beaches, 1952-61

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Mean 1952-61	Mean 1953-61
Jan.	—	50	1	4	3	2	—	3	3	—	—	7.3
Feb.	—	4	—	1	4	4	—	4	4	2	—	3.3
Mar.	12	14	17	1	3	—	4	6	1	1	5.9	5.9
Apr.	31	2	3	3	2	2	1	3	2	—	4.9	2.0
May	5	3	2	2	2	4	5	5	4	3	3.5	3.3
June	34	3	12	7	25	3	5	6	3	—	9.8	7.1
July ..	24	—	—	—	2	—	26	2	2	6	6.2	4.2
Aug. ..	6	—	1	2	4	—	—	3	1	—	1.7	1.2
Sept.	1	—	—	2	—	3	2	2	4	—	1.4	1.4
Oct.	4	2	—	2	—	—	17	7	2	1	3.5	3.4
Nov.	12	—	5	1	1	5	8	7	3	—	4.2	3.3
Dec.	5	4	5	3	2	7	—	2	7	—	3.5	3 3
Total ..	134	82	46	28	48	30	68	50	36	13		

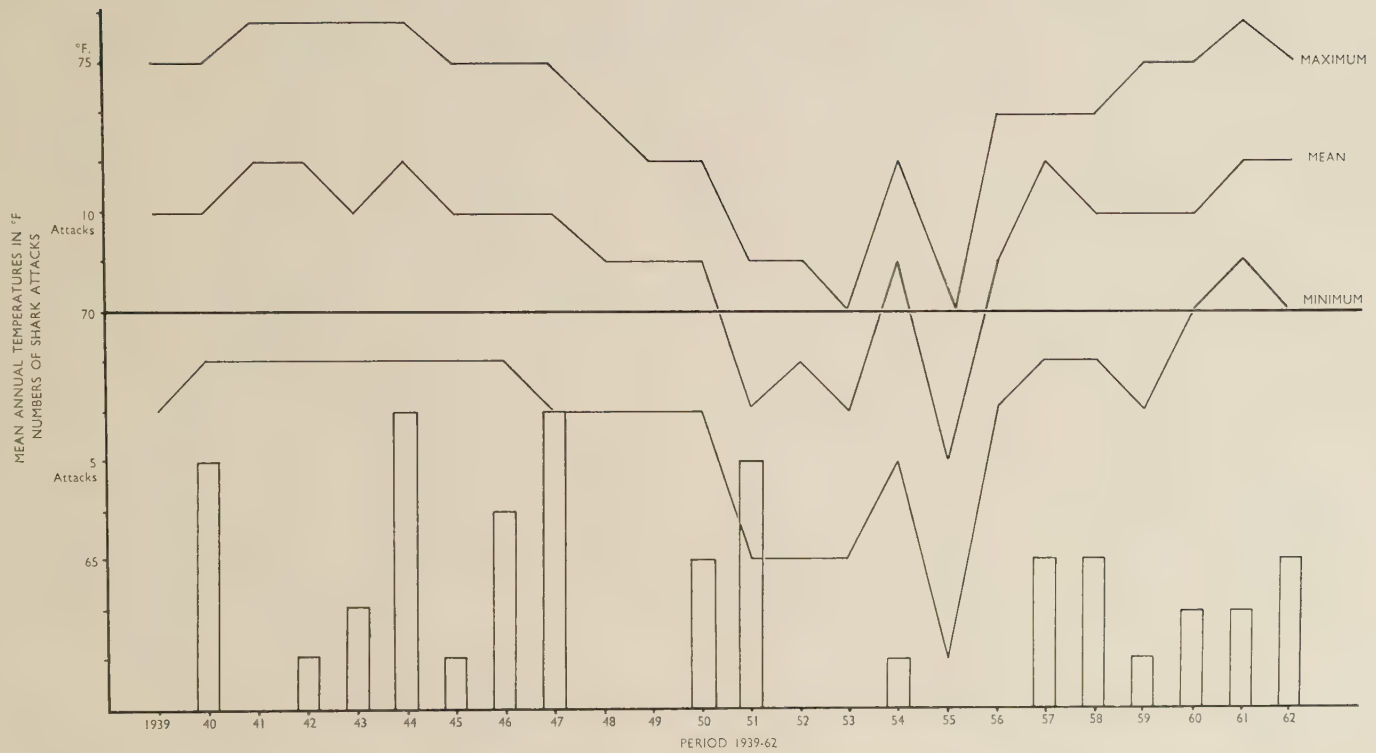

PLATE I MEAN ANNUAL TEMPERATURES (TAKEN AT NORTH BEACH, DURBAN) AND NUMBERS OF SHARK ATTACKS IN NATAL, 1939-62

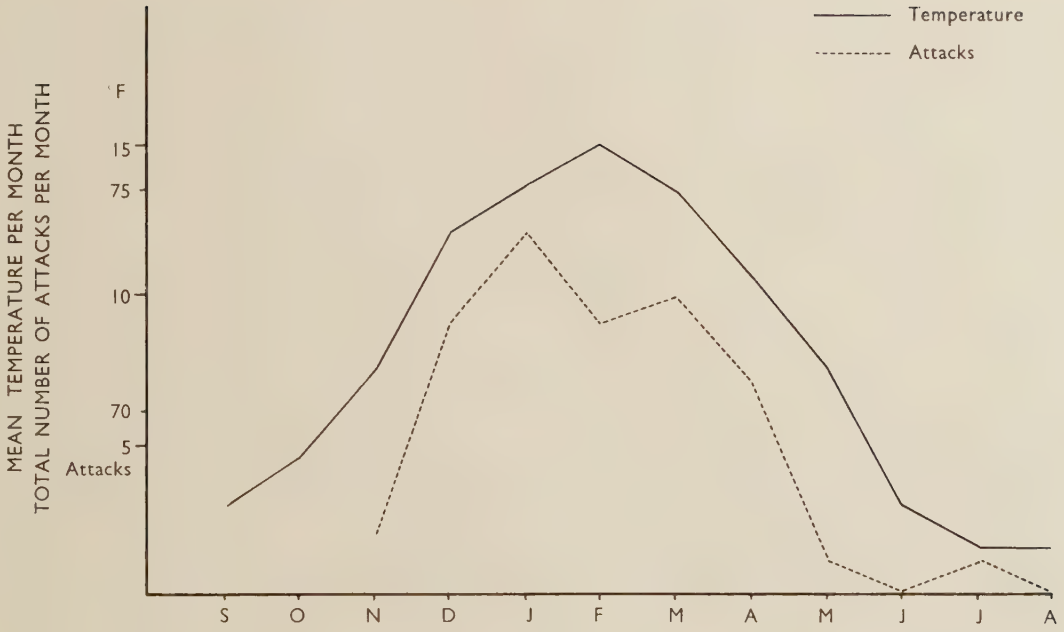

PLATE 2. MEAN TEMPERATURES AND TOTAL NUMBER OF SHARK ATTACKS PER MONTH, 1940-61

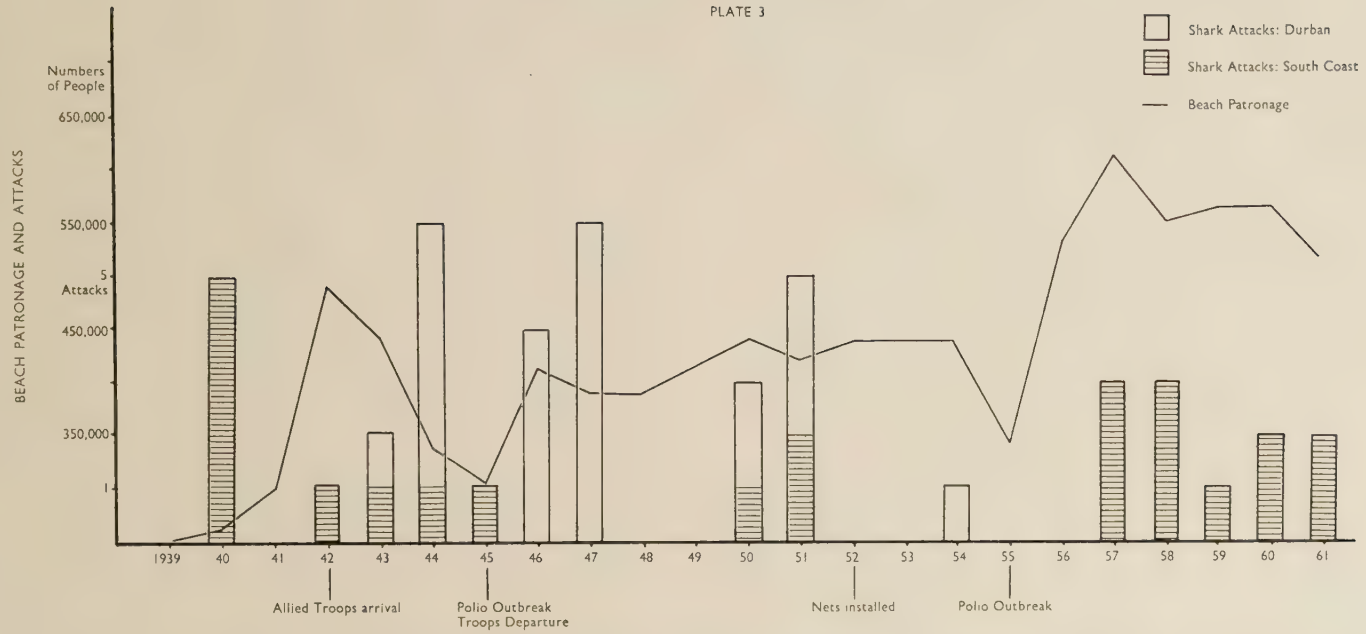

PLATE 3 PATRONAGE OF DURBAN BEACHES AND NUMBERS OF SHARK ATTACKS OFF DURBAN AND THE NATAL SOUTH COAST, 1939-61

PLATE 4 MEAN BEACH PATRONAGE FOR FIVE YEAR PERIODS, 1932-61

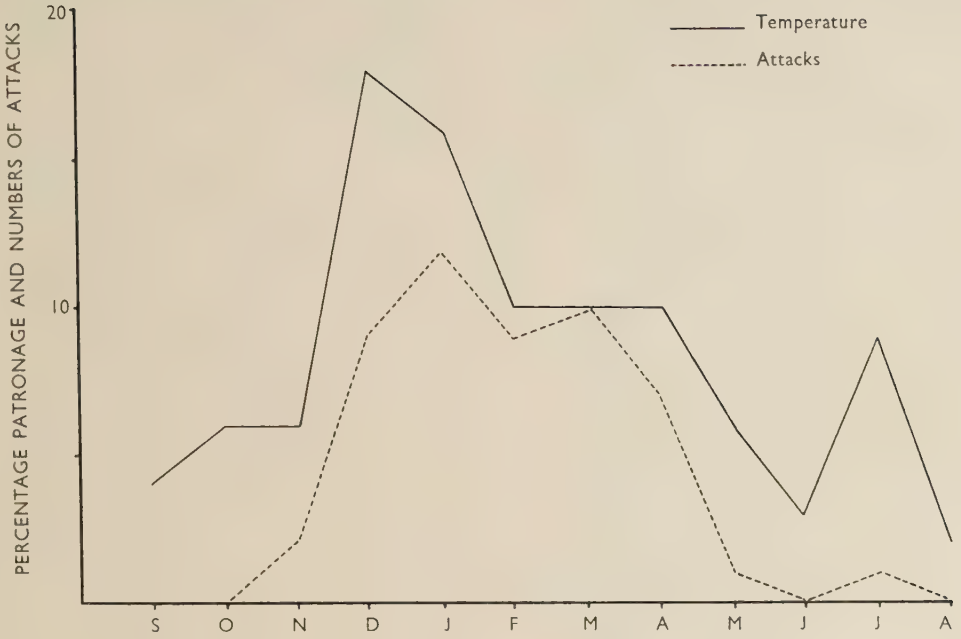

PLATE 5. MEAN MONTHLY BEACH PATRONAGE, DURBAN 1955-61 AND TOTAL NUMBER OF SHARK ATTACKS PER MONTH, 1940-62

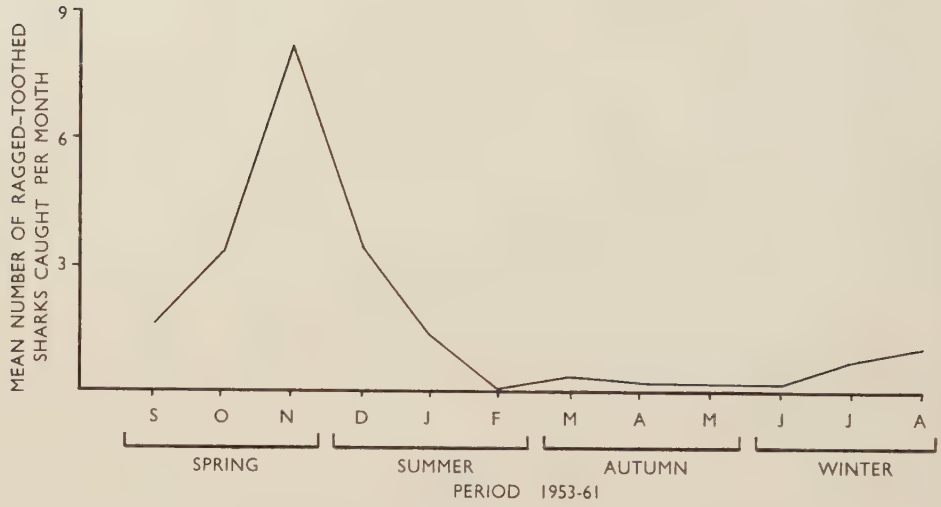

Fig 1. SEASONAL VARIATION IN ABUNDANCE OF RAGGED-TOOTHED SHARKS OFF DURBAN

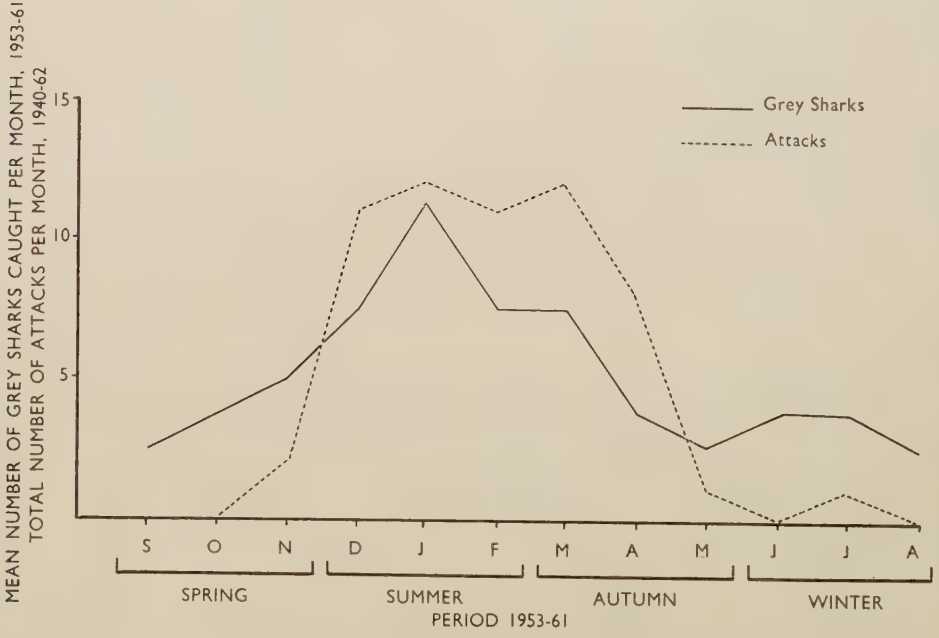

Fig. 2. SEASONAL VARIATION IN THE ABUNDANCE OF GREY SHARKS OFF DURBAN, 1953-61 AND TOTAL NUMBER OF ATTACKS PER MONTH, 1940-62

PLATE 6

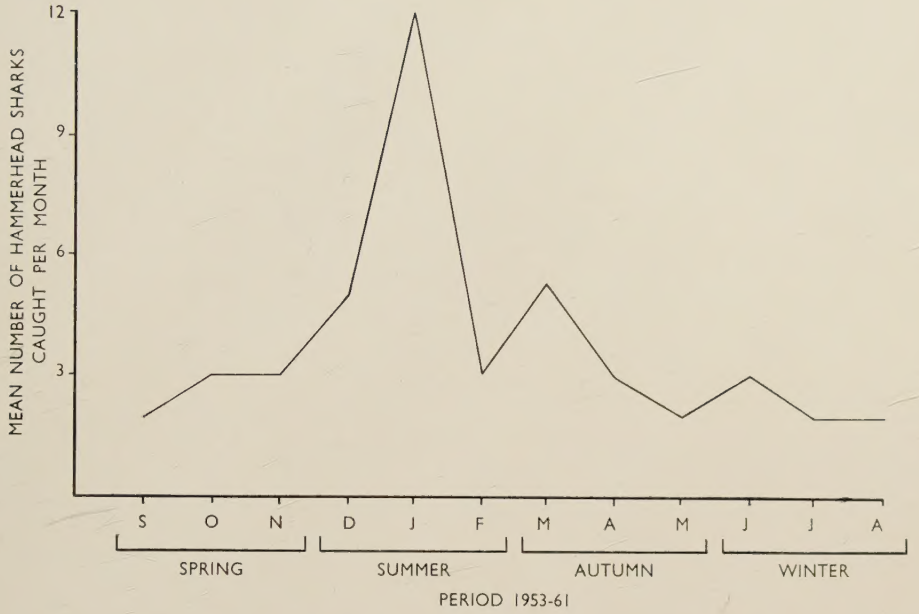

Fig. 1. SEASONAL VARIATION IN ABUNDANCE OF HAMMERHEADS OFF DURBAN

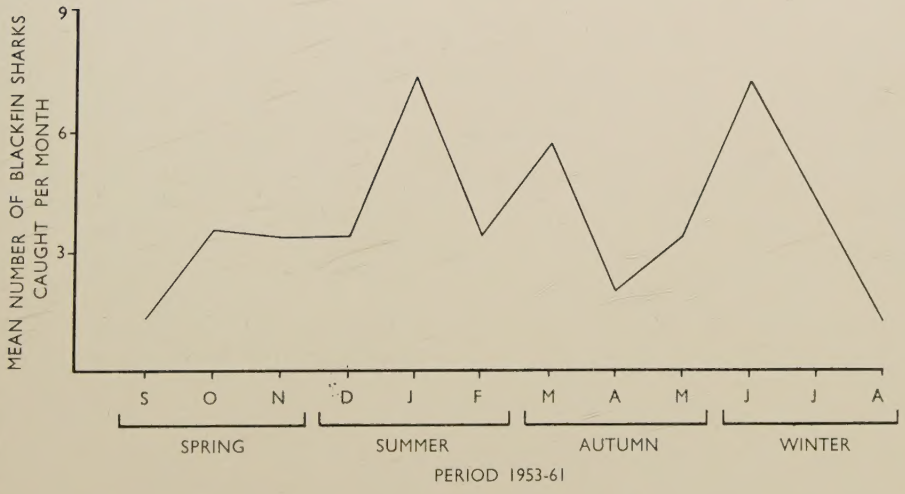

Fig. 2. SEASONAL VARIATION IN ABUNDANCE OF BLACKFIN SHARKS OFF DURBAN

PLATE 7

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